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ABSTRACT

This guide contains basic information to meet specific standards for pesticide applicators. Common forest pests and their control are discussed. Special attention is given to the effectiveness of different application techniques and potential human and environmental hazards. (CS)

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APPLY PESTICIDES CORRECTLY
A GUIDE FOR COMMERCIAL APPLICATORS

FOREST PEST CONTROL

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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PREFACE

Federal regulations establish general and specific standards that you must meet before you can use certain pesticides. Your State will provide materials which you may study to help you meet the *general* standards. This guide contains basic information to help you meet the *specific* standards for applicators who are engaged in forest pest control.

Because the guide was prepared to cover the entire nation, some information important to your State may not be included. The State Agency in charge of your training can provide the other materials you should study.

This guide will give you information about:

- types of forests,
- characteristics of common forest pests,
- pest control methods,
- pesticides and application equipment used in forestry, and
- environmental and human hazards.

INTRODUCTION

Control of forest pests is a long-term proposition. The goal is to keep pest populations at a level low enough to prevent destruction of forest trees. Chemical pest control must be combined with other management methods to minimize recurrence of pest problems.

FOREST REGIONS OF THE UNITED STATES

WESTERN FORESTS

ROCKY MOUNTAIN FOREST

Ponderosa pine; Idaho white pine; western larch; Engelmann spruce; Douglas fir; lodgepole pine; sugar pine; western red cedar; western hemlock; white fir; and others.

Surplus conifers, shrubs, dwarf mistletoes, and bark beetles are important pests.

Western Pine Region.

Douglas fir; western hemlock; redwood; western red cedar; Sitka spruce; sugar pine; lodgepole pine; incense cedar; white fir; Port Orford cedar; and others.

Hardwoods, shrubs, bark beetles, and deer are important pests.

PACIFIC COAST FOREST

Douglas Fir and California Redwood Region.

ALASKAN COAST FOREST

Sitka spruce; western hemlock; western red cedar; Alaska cedar.

Shrubs, browsing animals and defoliator insects are principal pests.

ALASKAN INTERIOR FOREST

White spruce; white birch; and black spruce.

Shrubs and browsing animals are principal pests.

CENTRAL HARDWOOD FORESTS

NORTHERN PORTION

Oaks; hickories; ashes; elms; maples; beech; black walnut; pitch, shortleaf and Virginia pines; cottonwood; and others.

Low-grade hardwoods, deer and gypsy moths are principal pests.

Appalachian Hardwood Region.

SOUTHERN PORTION

Oaks; red and black gums; hickories; ashes, black walnut; eastern red cedar; cottonwood; yellow poplar; beech; and others.

Low-grade hardwoods, deer, and heart-rotting fungi are principal pests.

Southern Hardwood Region.

EASTERN FORESTS

NORTHERN FORESTS

Red, black and white spruces; balsam fir; white, red, jack and pitch pines; eastern hemlock; maples, oaks, beech, birches, and aspen.

Low-grade hardwoods, deer, spruce budworm and balsam woody aphid are important pests.

Northern Pine and Hemlock and Northern Hardwood Regions.

SOUTHERN FORESTS

Longleaf, shortleaf, loblolly and slash pines; southern oaks; red gum; hickories; southern cypress; western and southern red cedars; and others.

Low-grade hardwoods, southern pine beetle, Fomes annosus, root rot, and fusiform rust are principal pests.

Southern Pine and Southern Hardwood Regions.

TROPICAL FOREST

Evergreen or deciduous tropical hardwoods.

Low-value trees, defoliating insects are principal pests.

Poor harvesting practices have left forest problems such as weed trees, brush, and weed-covered lands without commercial stands. Fire control efforts increase pest-susceptible species. Increased travel of man helps introduce weeds, insects, diseases, and animals which may cause widespread damage. Forests are attractive to people for the beauty of the scenery, the abundance of wildlife, and the quiet environment. Choose effective pest control methods that are the least disruptive of these values.

Tree cover affects all other forest resources (water, wildlife, and esthetics). Methods used to improve or protect the tree cover have a great influence on the other resources. Pesticides are not generally used except to improve the timber. Take care to avoid injury to the other resources.

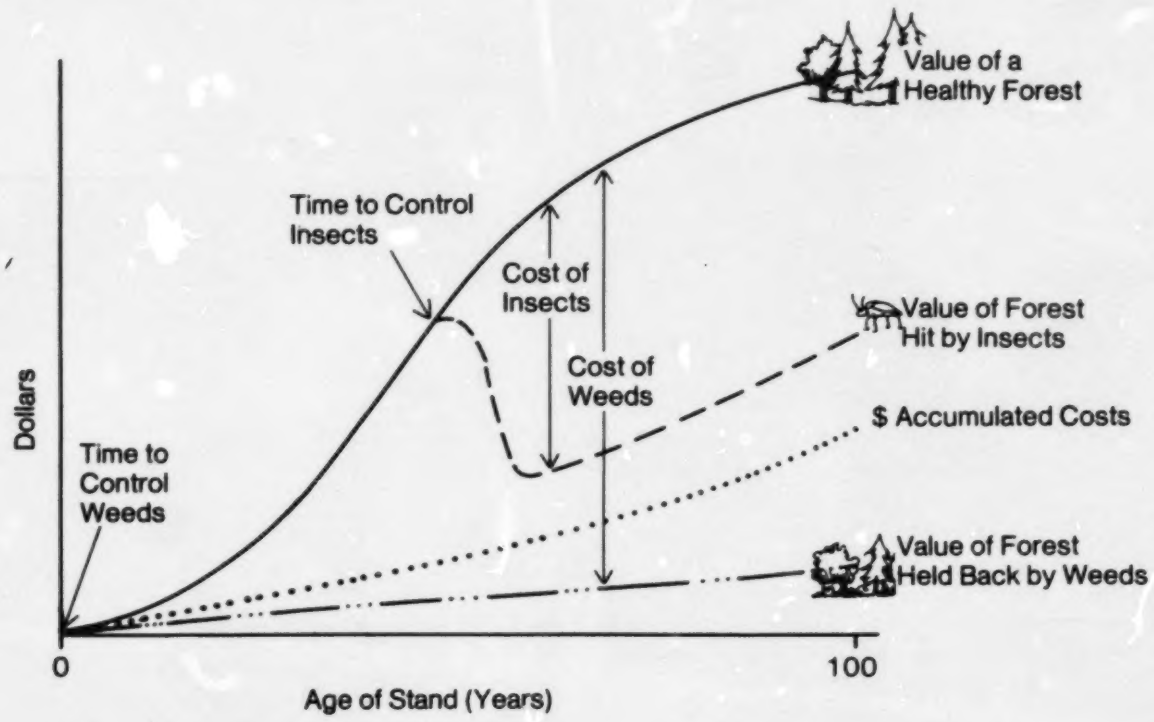
Habitat management will control many forest pests. Good vegetation control and management will not only control pests, but will enhance the timber production and may permanently solve some forest problems.

FOREST TYPES

The preceding map shows the principal natural forest regions of the United States, and the important kinds of natural forest communities and pests within each region.

All regions have second and third generations of man-made forests. These usually are even-aged stands of a single species. They often are composed of:

- trees not native to the area, or
- native trees which do not normally grow in single species stands of high density. Many of the major insect and disease problems occur in such man-made forests.



FOREST PESTS—RECOGNITION AND CONTROL

WEEDS

Weeds are plants that interfere with land management objectives. Weeds cause more forest losses than all other pests combined. Inadequate control of forest weeds is causing a major shortage in future supplies of high quality wood products. Weeds may be classed as:

- weed trees,
- brush,
- vines, and
- herbaceous weeds.

Weed Trees

Weed trees often cause significant losses in forest production. They affect both young and old commercial trees within the stand. Included are:

- noncommercial hardwood and conifer species,
- deformed, defective, or undersized individuals of commercial species (such as crooked trees or those with heart rot), and
- offsite species (commercial species in a location where they cannot develop well).

Some weed trees may be removed by mechanical methods. Some of these can be sold as pulp or fuel. Chemical control methods include:

- broadcast foliar application of herbicides,
- directed basal-cut application of herbicides to individual trees,
- directed basal bark application of herbicides, and
- broadcast soil application of herbicides.

BROADCAST FOLIAR APPLICATIONS of herbicides (usually aerial sprays) are used for:

- Site preparation—Preparation of ground for planting. Treat during early or middle part of the growing season. Using a controlled fire afterwards may be helpful.
- Release—Removal of hardwoods from coniferous stands. Make the application during the season when hardwoods will be controlled with minimum damage to conifers. The label will tell you the correct season for using the herbicides and the dosage at which it is selective. Season is important.

DIRECTED BASAL-CUT APPLICATION OF HERBICIDE TO INDIVIDUAL TREES. Aerial sprays are ineffective on some hardwood species. Noncommercial trees remaining after aerial application must be treated individually. Otherwise, they may reseed and crowd out desired species.

Release desirable hardwoods by using individual stem treatments on competing trees. Directed basal-cut treatment usually involves applying water-soluble amines or various other salts of herbicides in concentrated form to cut surfaces. The cut surfaces are created by:

- Girdling—removing 4-inch chips into the sapwood to completely encircle the tree bole. Applying herbicide spray to the girdle will hasten top-kill and retard basal sprouting.
- Frilling—encircling the bole with a series of overlapping single line ax cuts which penetrate the cambium. A herbicide must be applied to insure kill by preventing bridging. Apply the herbicide spray to the frill.
- Felling the tree and wetting margins of cut stump surfaces with concentrated herbicide spray.
- Trunk injection—using special tools (such as the tree injector or modified hatchets) that inject herbicide concentrate.
- Putting granular herbicide (ammonium sulfamate) into ax-cut cups spaced around the base of the tree near the ground line.

DIRECTED BASAL BARK APPLICATION to individual trees consists of spraying a herbicide in oil solution on the bark of the lower one foot or bole and exposed roots to the point of runoff. The entire root collar must be treated without gaps. Remove debris first.

Basal Bark Treatment

BROADCAST SOIL APPLICATION OF HERBICIDES can be used to kill trees. They are not always effective. Use them with care to avoid leaving residues in soil that are harmful to desirable

trees. Spot treatments are more useful than broadcast applications.

Brush

Brush includes:

- woody shrubs, and
- noncommercial stump sprouts.

Dense brush keeps light from tree seedlings. It also can deprive taller commercial species of water and nutrients. It interferes with planting and can create habitat for wildlife species that may damage tree seedlings.

Broadcast applications of foliar herbicides are used for general or selective control of susceptible brush species. If the brush is not over 20 feet high, air blast sprayers may be used for ground application. Aircraft are usually used on taller vegetation.

Application of chemicals to individual stems can be expensive if large numbers of stems per acre are treated. Basal bark applications are effective, but are costly in labor, chemical, and fuel oil. Systemic brush-killing herbicides do the best job of controlling large woody vegetation.

Vines

Greenbriar, Japanese honeysuckle, wild grapes, kudzu, and other vines are serious pests, especially on better forest soils. They strangle trees, drag down branches and crowns, and compete for light and nutrients. Poison ivy is a human health hazard. Vines are the most difficult weeds to control. They have vigorous sprouting habits. Systemic herbicides kill their root systems.

Herbaceous Weeds

Herbaceous weeds compete with seedlings in new plantations. The seedlings may develop poorly or die, especially in time of drought. Herbaceous weeds also create favorable cover for tree-damaging animals such as mice, gophers, and moles. Control herbaceous weeds with herbicides labeled for this forest use. Killing all ground cover for several years can cause soil damage, especially from loss of nutrients and from erosion. Use banded application in areas with summer rainfall. In dry-summer climates, short-residual herbicides permit winter ground cover to develop.

For herbaceous weed control in new plantings, apply herbicides in the spring before growth of tree seedlings begins. Chemicals that injure planted trees on contact may have to be applied before planting or be used as directed spray.

Herbaceous weeds recover rapidly after treatment with contact herbicides. Use residual herbicides to extend weed control through the tree seedlings' first growing season.

Weeds of Special Importance in Small-acreage Forest Crops

Forest nurseries, seed orchards, and Christmas tree plantings should be completely free of weed trees, brush, and vines. Herbaceous weed control is critical in these high-value forest crops.

Control of herbaceous weeds in forest nurseries requires continuing effort throughout the growing season. Mechanical and hand weeding are still common. Preemergence herbicides are sometimes used for selective weed control in conifer nurseries.

Seasonal variation in herbicidal effect on tree seedlings is critical. Use contact herbicides when trees are resistant and residual herbicides to carry through sensitive period.

For control of both weeds and diseases, fumigants can be used before seeding. Fumigants may injure desirable fungi and should not be used for general weed control.

Herbaceous weeds may limit seed production in seed orchards. They may be controlled by mowing and chemical applications. Herbaceous weeds retard the growth of Christmas trees and may seriously damage their shape.

Herbicides

You must understand the terms used on herbicide labels to describe their uses in forestry. These terms include:

- Reforestation—the process of establishing tree seedlings.
- Site preparation—preparing an area for reforestation by clearing or other vegetation control.
- Plantation weed contol—using herbicides for selective weed control to insure survival and rapid growth of planted tree seedlings. This is one method of animal habitat management.

- Release—applying selective herbicides to woody or herbaceous weeds competing with commercial crop species.
- Desiccation—applying herbicides to vegetation in preparation for burning as part of site preparation.
- Timber stand improvement—selective removal of undesirable trees to improve growing conditions for desirable trees.
- Chemical precommercial thinning—removing all excess trees in a young forest by applying chemicals to individual trees. Herbicides labeled for basal spraying, cut-surface application, trunk injection, frilling, or stump treatment may be used for this purpose.
- Preharvest drying of softwood timber—the treatment of trees with chemicals to allow timber to season before cutting. May also loosen bark and control insects and diseases. Herbicides registered for conifer thinning may be used for this purpose.
- Dormant spray—applying before buds open in the spring, or after trees go dormant in the fall.
- Early foliage spray—application while new growth is elongating rapidly, but after first leaves are fully expanded.
- Summer foliage spray—application to mature foliage near midsummer.
- Fall foliage spray—application in late summer to early fall, generally used with readily translocated herbicides.
- Cut-surface—includes trunk injection, bore-hole, frill, frill-girdle, girdle and stump treatment.
- High-volume ground spray—application of herbicide to low brush with power sprayer delivering enough volume to wet foliage to the drip point. Noncrop herbicides may be used when crop species are not present.
- Low-volume spray—broadcast application by aircraft or ground rig, including air blast sprayers, at the rate of 30 gallons per acre or less. Does not soak foliage. Aircraft application must be specified on the label. Forestry use must appear on the label if crop species are affected.

Herbicides generally move very little in forest soils. They are broken down in place by microorganisms, sunlight, and chemical reactions. A compound that has an effective life of several months will usually move less than a foot or two from the site of application. Therefore, herbicides are not a serious threat to water supplies or fish unless they are placed directly (especially by spillage) into forest streams or on areas which will become waterways during storm periods.

INSECTS

The major groups of insects affecting forests are:
- defoliators,
- bark beetles,
- suckling insects,
- shoot borers, and
- wood borers.

DEFOLIATORS include:
- forest tent caterpillar,
- gypsy moth,
- tussock moth,
- spruce budworm, and
- loopers.

The larvae of defoliators feed on buds, flowers, and leaves of both hardwood and coniferous trees. Early spring defoliation often keeps the trees from fruiting, reducing regeneration potential.

Defoliation suppresses shoot development and growth rates. Repeated defoliation can kill the trees. Symptoms are the trees obviously stripped of foliage. One or more hatches may occur each year depending on species and climate. The nonpersistent insecticides are most commonly used for control. Apply insecticides from aircraft:
- in low volumes of oil or water mixtures, or
- in ultra-low volumes of a few ounces per acre of undiluted formulation concentrate.

Timing of the application is critical to insure that:
- the entire hatch has emerged or will be exposed in later sprays, and
- damage has not progressed past a harmful point.

BARK BEETLES include:
- the southern pine beetle,
- the western pine beetle, and
- the European elm bark beetle.

Bark beetles normally kill some trees each year. In epidemic years, they kill large numbers in some regions. Their effects are most severe in unthrifty stands and under adverse weather conditions.

Mature insects enter the tree and lay eggs in channels etched between the bark and wood of conifers and certain hardwoods. The larvae feed on cambium tissue. Their tunnels girdle a substantial portion of the tree. As the tree dies, adults emerge and fly to another tree. Trees may also be killed by the fungi introduced by some beetles.

Several hatches of bark beetle may occur each year, depending on species and region. Since adults are exposed for only a short time, beetles are seldom a good target for insecticides.

If the pest is recognized early, organic arsenical herbicides sometimes can be applied to the host tree by injection, killing the insects as the tree dies. Infested trees are sometimes felled and chemically treated. Insecticides are seldom used to control outbreaks except in recreational sites, seed orchards, Christmas tree plantations, or other high-value special-use areas.

SUCKING INSECTS include:
- the balsam woolly aphid, and
- the beech scale.

Sucking insects feed on plant fluids below the surfaces of bark and leaves. Mass attacks reduce vigor and kill shoots and leaves. Entire trees or stands may be killed. Sucking insects cause scaly, mealy, or powdery masses on trunks, twigs, and lower surfaces of leaves.

Contact insecticides must be used as sprays. Coverage is seldom complete, especially for insects on lower leaf surfaces. Systemic insecticides within the tree have better control potential.

SHOOT BORERS include both moths and weevils. Examples are:
- the pine tip moth, and
- the white pine weevil.

Eggs are laid on both terminal and lateral shoots. Developing larvae bore down the pith, killing the shoot. Recognition is by dead shoots and presence of larvae in central channels. Borers seldom kill trees, but they slow tree growth and cause malformed seedlings.

Since some species of shoot borer have several hatches each season, use systemic insecticides.

WOOD BORERS include:
- oak borers, and
- turpentine borers.

Wood borers channel in the tree bole and lower the quality of the wood. Secondary damage is caused by fungi that produce stains and mar the appearances and utility of products. Borers leave holes in the bark that frequently exude sap. There is no economical control by insecticides, except for protection of cut timber.

Insecticides

Few insecticides can be used for broadcast applications in forests. Forest insecticides are used mainly to combat widespread epidemics such as gypsy moth and spruce budworm, in regional control programs, and to spot treat individual plots in nurseries, seed orchards, and Christmas tree plantations.

Like herbicides, insecticides are not highly mobile in soil. Keep insecticides away from open water by leaving adequate buffer strips along streams and impoundments when applying by air.

DISEASES

In terms of losses to future forest production, the rusts, root rots, and dwarf misteltoes are the most important diseases.

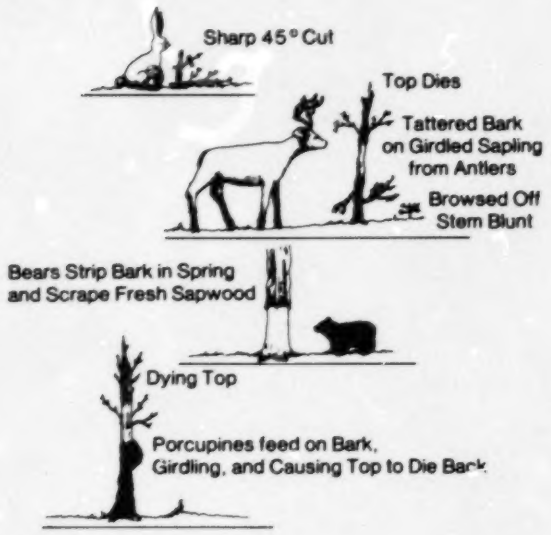
Fungicides are not available for use in forests. Diseases cause heavy losses in forest nurseries. Some soil fumigants and fungicide sprays can be used in nurseries. Nursery diseases can be separated into these types:
- root and soilborne diseases, controlled by fumigation,
- stem and branch diseases, and foliage diseases, may be prevented with fungicide sprays.

Many nurseries fumigate to control weeds, and disease control is a secondary benefit. Where major disease problems are known to exist, fumigation can be used specifically for disease control. Fumigants are nonselective.

VERTEBRATES

Animals damage trees at all stages in the development of the forest.

- Seed-eating birds and mammals can be an important limiting factor in natural forest regeneration.
- Browsing animals like deer and rabbits can deform or kill seedlings.
- Mice and mountain beaver can kill seedlings by completely debarking them.
- Birds and rodents that feed on buds can seriously deform trees.
- Pocket gophers, wild hogs, and mice can destroy root systems of saplings, and occasionally larger trees.
- Bears, porcupines, mice, wood rats, and squirrels can kill larger trees by girdling.
- Beaver, besides felling trees, cause extensive timber losses from water impoundments.


Sharp 45° Cut
Top Dies
Tattered Bark on Girdled Sapling from Antlers
Browsed Off Stem Blunt
Bears Strip Bark in Spring and Scrape Fresh Sapwood
Dying Top
Porcupines feed on Bark, Girdling, and Causing Top to Die Back

Control of vertebrates usually is not feasible except in intensively managed forests or in nurseries.

- Cultural methods include the use of tree species on which the pest will not feed, and the use of planting stock large enough to be beyond the vulnerable stage.
- Physical control includes fencing large tracts, installing protectors around individual trees, and shooting or trapping.
- Chemical control includes the use of repellents and baits. Many of the baits have low concentrations of active ingredients (less than 2 percent) because of their extreme hazard to all warm-blooded animals.

  Because of the reproductive potential and movements of pest animals, baited areas are soon restocked with target animals, making this method ineffective for long-term control.

PESTICIDE LABELING

Forest lands are considered to be cropland when a stand of commercial trees is present. This means that "noncropland uses" listed on a pesticide label may not apply to forests. Pesticides used in forests, seed orchards, Christmas tree plantations, or nurseries must bear directions for use on the specific crop and pest species.

Some forestry uses are included on labels principally devoted to other uses. For example, pesticides may be applied to Christmas trees, seed orchards, or nurseries if the label gives directions for use:

- on ornamentals or shade trees, including conifers, and
- for the pest you need to control.

Herbicides registered for other crops, range, or non-crop lands may be used before crop trees are planted. Some pesticides registered for use in forestry may be tank mixed. In mixtures of two or more products, the rate of each component may not exceed the rate prescribed on its label. Check labels or recognized authority for details.

APPLICATION

Aircraft are used for most forest pesticides applications. Other techniques include the use of:

- **air blast sprayers**—Air blast sprayers are used most often for applying herbicides to brush under conifer stands, or for selective brush control in regenerating stands. In these cases, the standing trees restrict air movement. This provides some drift control.

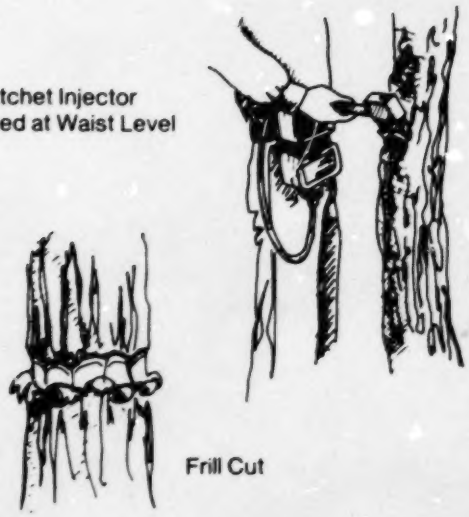
When using an air blast sprayer in forests:
Work on a calm day (less than 5 mph wind).
Apply herbicides only in timber production areas.
Follow local regulations regarding distance from crops.
Use operating pressure less than 20 psi.
Use the largest practical nozzle openings.
Do not spray under stands of sensitive desirable trees.
Do not spray near recreation areas.

- **tree injectors**—Tree injectors are used to control woody species that have passed the "brush" stage. A tree injector makes a wound through tree bark and places herbicide in the wound. It may be a pipe with a chisel-like bit on the lower end, or a hatchet with built-in calibrated pump. Chisel types are directed at the base of the tree. Hatchet types are used at any convenient level. Injections are usually spaced 1 to 4 inches apart, depending on species and chemical.

Herbicides used in injectors should be water-soluble salts. They are usually used full-strength but can be used diluted in unmetered injectors. Esters are less effective.

- **directed sprayers**—Some herbicides that control weeds can also damage trees. Hand sprayers equipped with shields or with directional nozzles can prevent damage to seedlings. Such equipment also can be mounted on tree planting machines so that weeds can be treated while seedlings are being planted if label requirements are met.

Injectors Apply Herbicides in Continuous Frills or Space Cuts at the Base of the Tree or at Waist Height



ENVIRONMENTAL HAZARDS

The most serious adverse effects of misuse of forest pesticides are:

- Damage to desirable trees.
- Injury to desirable soil organisms.
- Elimination of desirable predator and pollinator insects.
- Unwanted changes in wildlife habitat.
- Drift damage to adjacent crops.
- Direct poisoning of nontarget birds and mammals.
- Injury to fish from application to open water.
- Soil erosion from prolonged devegetation by repeated use of residual herbicides.

Some adverse effects are likely even with correct use practices. Pest control decisions must minimize the adverse effects and weigh them against the benefits.

Every part of a forest changes somewhat when another part is removed. Since pesticides act by removing living things, the entire forest responds when a pesticide is used. Although the target could be the only organism affected directly, other organisms may be affected indirectly if they depend on the one(s) removed.

Removing any kind of plants, for example, helps the ones that remain to grow better, whether they are wanted or unwanted.

Weigh the environmental consequences of pesticide used against those of nonuse. The adverse effects of *not* using a pesticide may last for many decades in a forest. These effects may include:

- continuing weed problems which may keep desirable trees from growing,
- insect epidemics which may totally destroy the forest or change the species composition,
- loss of seedlings in nurseries, and
- an increase in the time needed for reforestation.

HUMAN HAZARDS

Pesticides used in forests seldom come in contact with humans at exposure rates high enough to cause injury. The risk is greatest for applicators, ground personnel, flagmen, or forest workers. Observe all necessary safety precautions during and after pesticide application.